

# REPORT DOCUMENTATION PAGE

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# High Performance Hall Thruster Ground Demo

**Air Force Research Laboratory**

**Spacecraft Propulsion Branch**

**Dr. John Michael Fife**

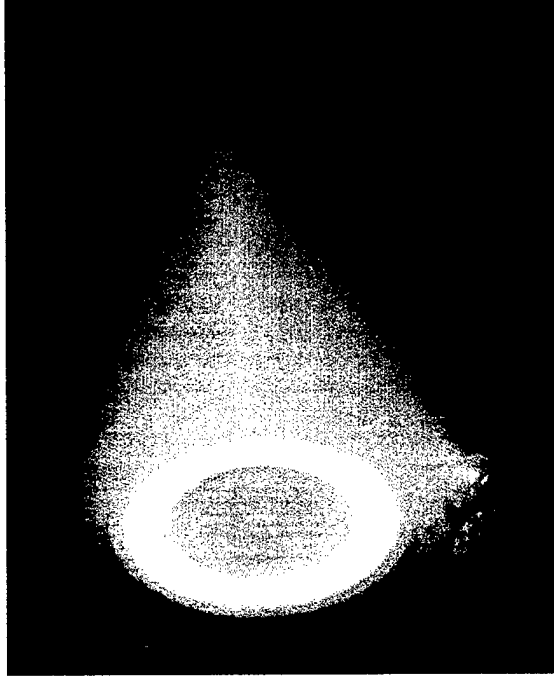
**September, 1999**

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# Hall System Outline

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- **Goal & Objectives**
- **Payoffs**
- **System Concept**
- **Milestones**
- **Hall System Development**
- **Summary**
- **Conclusions**



# Hall System Goals

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**OBJECTIVE:** To develop and demonstrate the electric propulsion technology needed to meet the IHP RPT Phase I Goal

	<u>Goal</u>
<b>Efficiency</b>	<b>55%</b>
<b>Life</b>	<b>7200 hrs</b>
<b>Specific Mass</b>	<b>5.7 kg/kW</b>
<b>Isp</b>	<b>1801* seconds</b>

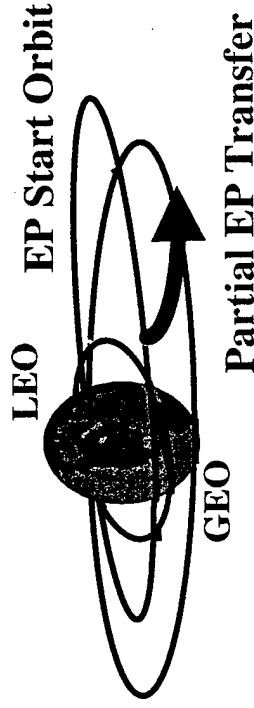
\* 300 V PPU

# Full System Payoffs

## Orbit Raising

### Missions

- LEO Spiral Transfer (SBR, SBL)
- Apogee Insertion (GEO comm)



### Spiral Transfer Payoffs (4 kWe):

- + 11 % LEO Atlas IIAS payload
- SBR to 850 km (121 Days)

### Apogee Payoffs (15 kWe):

- + 34% GEO Atlas IIAS payload
- \$32 M Net launch Savings (105 Days)

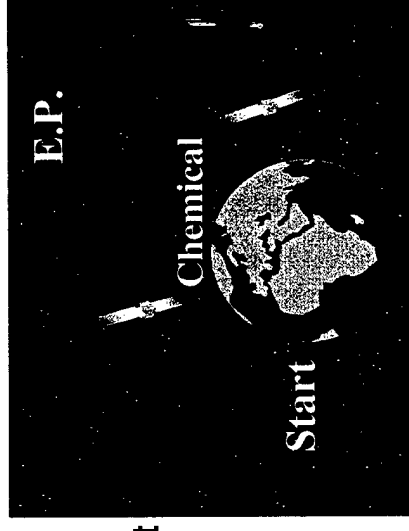
## Repositioning

Supports MAP deficiencies

- Repositioning Capability
- Recovery, repair, redeployment
- Global Mobility

### Payoffs

- 17% less fuel or more moves (EP baseline)
- Faster move vs. chem
- ~ 2 X faster for same propellant mass



## Stationkeeping

### Mission

- GEO Communications

### Payoffs

17% less fuel / more life (EP baseline)  
13% less power for same thrust (EP baseline)

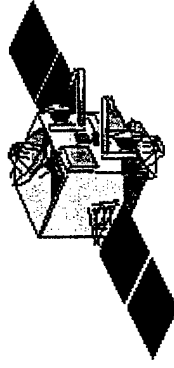
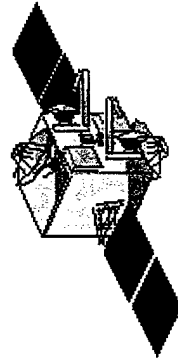
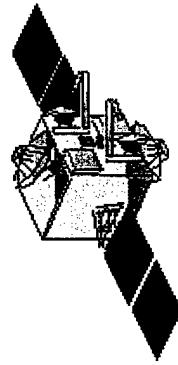
# Hall System Near Term Tech Transition Opportunity

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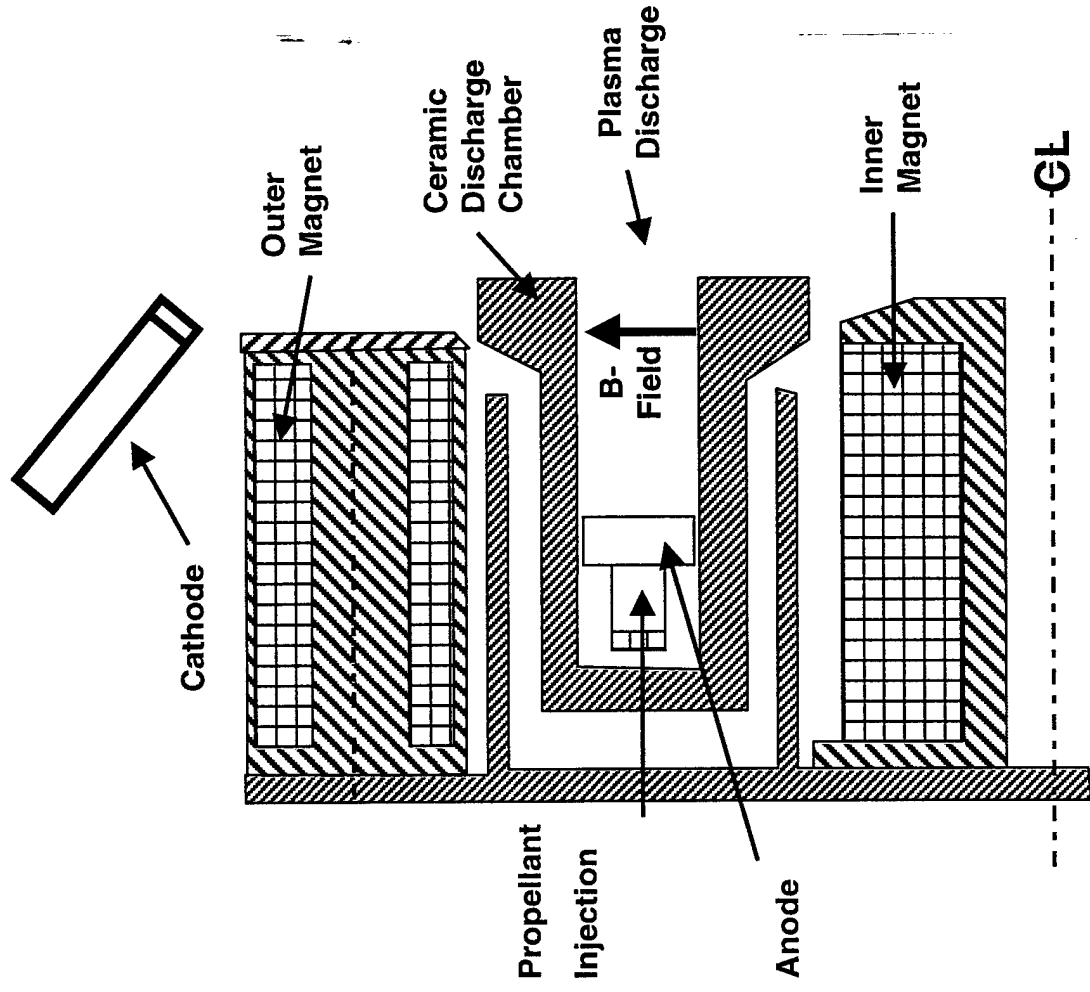
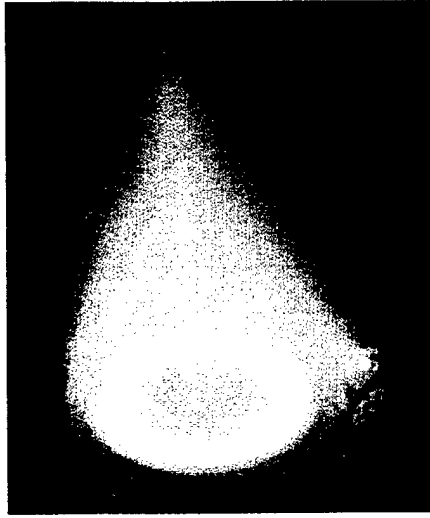
## **MILSATCOM Advanced EHF**

- Next Milstar System
- Approved Extended Duration Orbit Transfer
- Hall System Supports NSSK and Orbit Raising
- FY01 Tech Freeze
- FY06 Anticipated Launch



# Hall System

## Thruster Operation Background



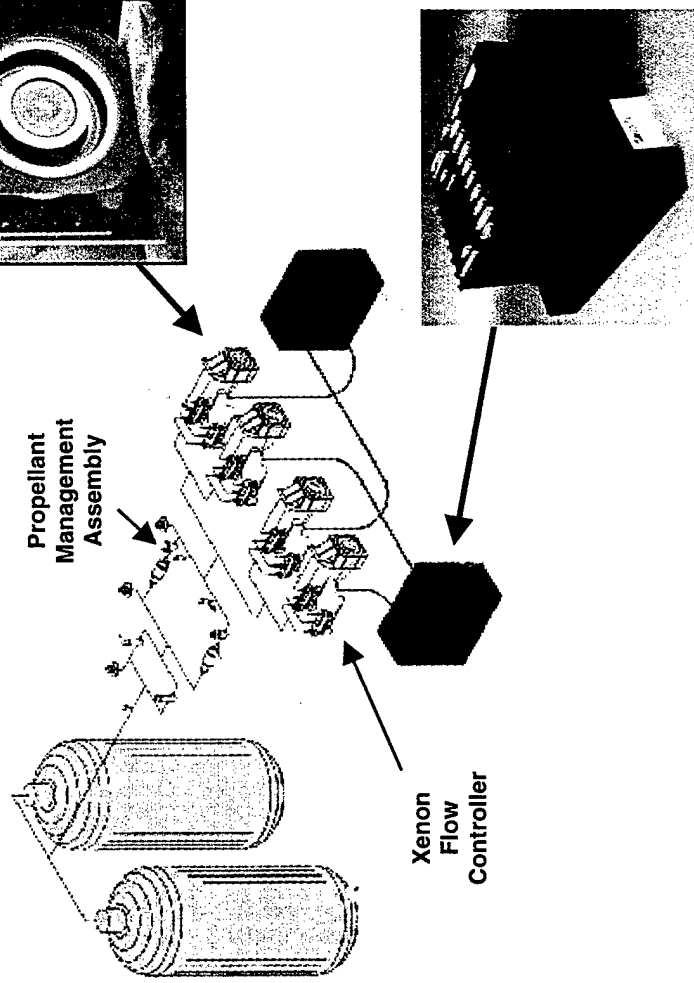
1. Electrons emitted from the cathode travel toward the anode.
2. Electrons are impeded in the discharge channel by a strong radial magnetic field, causing a strong axial electric field to concentrate in this region.
4. This electric field heats the electrons, which subsequently ionize gaseous propellant (xenon) emitted near the anode.
6. The ionized gas accelerates axially through the electric field in the discharge channel, exiting the device at high speed, thus producing thrust.



# Hall System Concept

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## HALL PROPULSION SYSTEM



Current results:  $I_{sp} = 1801$ , Effic = 58%

Current breadboard results: Effic > 94.4%

# ARC

# Sea Thruster System Program

## Milestones

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<u>Date</u>	<u>Accomplishment</u>
01/99	Phase I Thruster Development
01/99	PPU Breadboard Development
03/99	Thruster CDR
09/99	Thruster Performance, EMI, Contamination, Plume Testing in USA
10/99	PPU CDR
01/00	Thruster Thermal Integrated Test
01/00	PPU Thermal Integrated Test
02/00	System Integrated Functional Test
02/00	7200-Hour Life Test Begins at AFRL EP Lab
12/00	Project Complete
??/01	MILSATCOM Advanced EHF Tech Freeze
??/06	MILSATCOM Launch

**Project is Cost Shared**

**44% Paid by Contractor:**

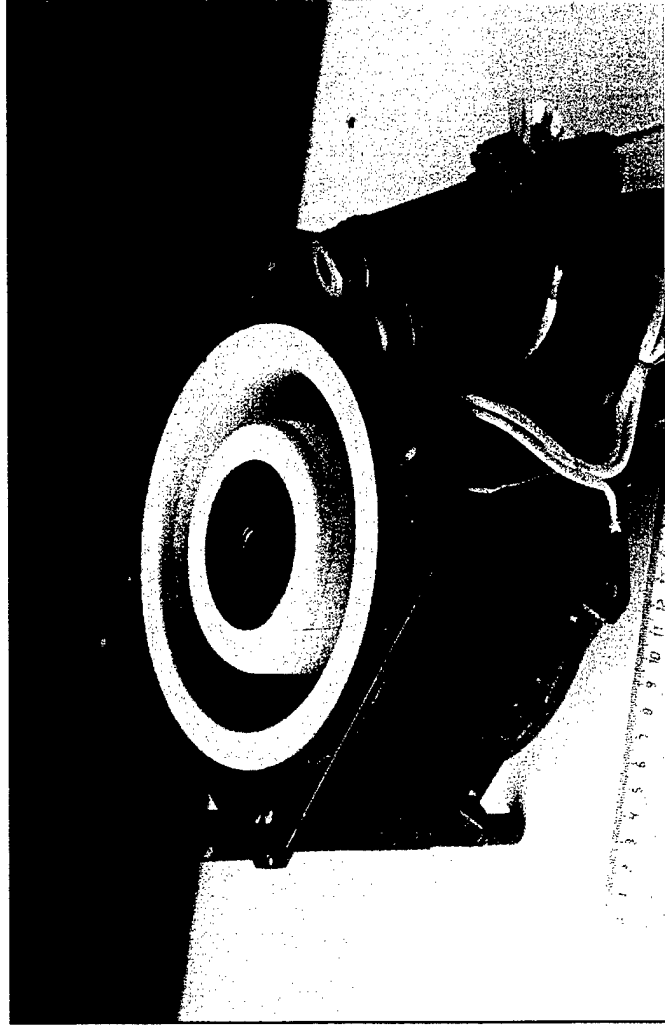
**Atlantic Research  
Corporation**

■ **Completed**

■ **Not Yet Completed**

# SPT-140 Demonstration Model Thruster

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SPT-140 Demonstration Model (DM)

Power: 4.5 kW

Thrust: 296 mN

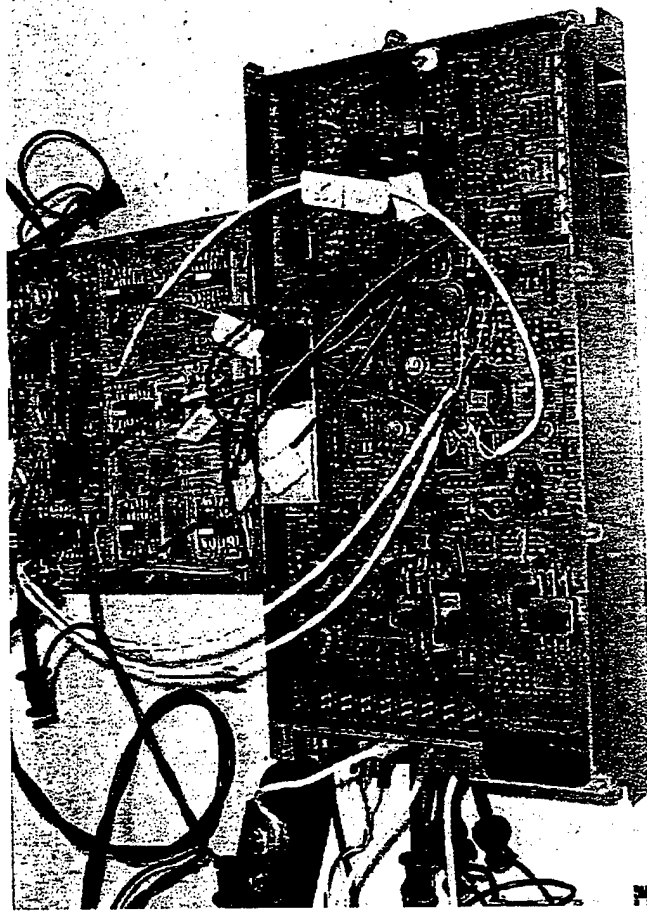
Efficiency: 58%

Tests Completed:

- Vibration
- Shock
- Thermal Cycling
- EMC
- Performance
- Contamination
- >1100 hr firing

# Hall System Anode Breadboard

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PPU-140 Breadboard Anode Module

Power: 4.5 kW

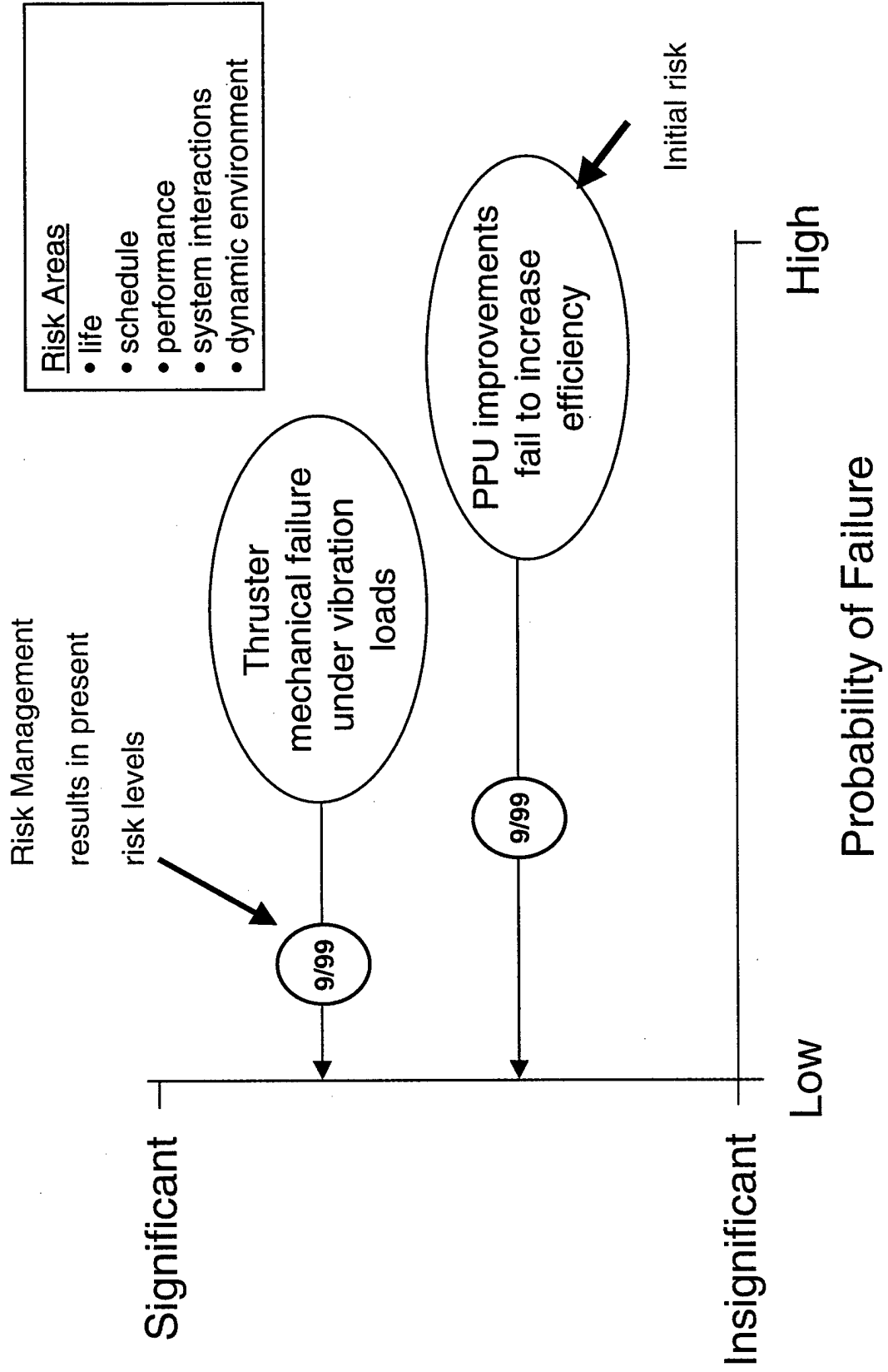
PPU Mission Average

Efficiency: 94.4%

Status:

- Breadboard Testing Completed
- Brassboard Anode Module Design Completed, Fabricated

# Full System Risk Assessment



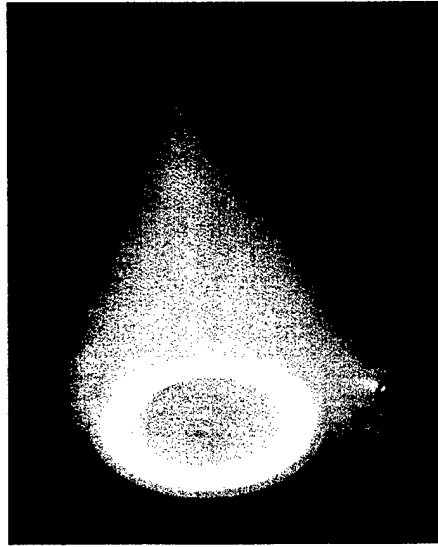
# Hel System Summary

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- Supports critical DoD missions
  - MILSATCOM Advanced EHF Opportunity
  - Orbit Raising, Repositioning, Stationkeeping
  - MAP Deficiencies
- Exceeds IHPRPT Phase I ES goal
- Demonstrates Flight Propulsion System

# Hall System Conclusion

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## Future Military Constellation Opportunities

**MILSATCOM Advanced EHF**

**GMTI & AMTI SBR to use 10-80 satellites**

## Efficient Orbit Raising ~ 100 days

- + 11% payload to LEO
- + 34% payload to GEO

## Improved Stationkeeping

17% less propellant  
than EP Baseline

## Supports Mission Area Plan (MAP) deficiencies

- Repositioning
- Recovery, Repair, Redeployment
- Global Mobility

